

THE UNIVERSITY OF NEBRASKA

THIRTY-SEVENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station

OF

NEBRASKA



Presented to the Governor February 1, 1924

LINCOLN, NEBRASKA
U. S. A.

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LETTER OF TRANSMITTAL

THE UNIVERSITY OF NEBRASKA AGRICULTURAL EXPERIMENT STATION

To His Excellency, Charles W. Bryan, Governor of Nebraska:

SIR: In accordance with the act of Congress approved March 2, 1887, and the act of the General Assembly of the State of Nebraska, approved March 31, 1887, establishing and regulating experiment stations, I have the honor herewith to submit the Thirty-seventh Annual Report of the Agricultural Experiment Station of Nebraska.

February 1, 1924.

E. A. BURNETT,
Director.

GOVERNOR'S CERTIFICATE

STATE OF NEBRASKA, EXECUTIVE DEPARTMENT

Lincoln, February 1, 1924.

Mr. E. A. Burnett, Director Nebraska Agricultural Experiment Station:

SIR: I hereby acknowledge receipt of the Thirty-seventh Annual Report of the Agricultural Experiment Station of Nebraska.

CHARLES W. BRYAN,
Governor.

Agricultural Experiment Station of Nebraska

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*By an act of the Legislature of the State of Nebraska, approved and in effect February 15, 1899, the State Treasurer became *ex officio* custodian of the Experiment Station fund on and after July 1, 1899.

**Detailed from the Office of Dry Land Agriculture, United States Department of Agriculture, Washington, D. C.

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THIRTY-SEVENTH ANNUAL REPORT¹

During the year covered by this Report satisfactory progress has been made in the investigational work carried on at the Experiment Station. Quite a number of problems under investigation have been brought to conclusion and the results assembled and published. A number of new lines of investigation have been added.

During the year a number of changes have taken place in the Experiment Station staff. In each case the place has been filled, and two additional appointments have been made. Some new equipment has been added for investigational work.

There is an increasing demand from the public for information along many lines. This is evidenced not only thru the correspondence received, but thru the number of plant and animal specimens received, with requests for direct information. The receipt of such specimens has been particularly heavy in the Department of Animal Pathology and the time required for taking care of this routine work is considerable. It is felt, however, that it is a proper function of the Experiment Station staff, and all such inquiries have been taken care of when they properly fell within our field.

INVESTIGATIONAL WORK

The investigational work of the Experiment Station is supported by both Federal and State funds. A financial statement, showing the expenditure of various funds allotted to the Experiment Station, is shown later on in this report.

The following brief summary shows most of the problems now under investigation and records the progress made during the past fiscal year.

AGRICULTURAL ENGINEERING

Tractor Testing. During the past year a number of tractors have been tested and notable improvements noted in most of these as compared with previous models tested. The most outstanding improvement noted was the ability of speed control devices, or governors, to perform their functions more perfectly than has been true in former years.

¹Acknowledgment is due to Assistant Director W. W. Burr for the preparation of the report dealing with the Experiment Station work.

The report of the Agricultural Extension Service is published in a separate bulletin.

Plow Draft Investigation. This work has been continued and considerable data have been obtained during the past year. However, results which have been so far secured are not sufficient to warrant definite conclusions.

Fuel Saving Devices, and treatments, for internal combustion engines. During the past year a number of representative fuel treating materials were tested with the object of determining whether the saving in fuel claimed by the makers of these materials could actually be made. Results obtained have led to the following conclusions:

The same results can be secured by proper adjustment of the carburetor without fuel savers as when these are used.

Gasoline improvers do not in general give a marked saving in fuel nor increase the mileage per gallon. When any improvement was noted it was so slight that it did not pay for the added cost of the improver.

Poultry House Ventilation and Construction. The purpose of this project is to secure data which will yield information for the proper design of poultry houses best suited to Nebraska conditions. This work is just being started.

ANIMAL DISEASES

Hemorrhagic Septicemia. This investigation is an endeavor to determine the organisms belonging to the hemorrhagic septicemia group and their development. It includes as well a study of the antigenic and biologic properties of the organism.

During the year covered by this Report it has been possible to produce a highly potent immune serum against the fowl cholera organism. It was also found that the immunity offered by this serum was of short duration and that it was not possible to lengthen or to activate this immunity by the introduction of virus during the immune period of the test animals. The department also attempted to determine to what extent the apparent immunizing properties of this serum can be utilized in field outbreaks. For this purpose a number of flocks in which there were more or less acute outbreaks were treated by members of the department. Some data were obtained but not yet in sufficient volume to warrant conclusions. After some 2,000 fowls had been treated, outbreaks ceased to occur in this vicinity. For this reason the project has become temporarily inactive, but will be resumed as soon as material will again become available. In the meantime,

care is being taken of the serum-producing horses and a stock of the serum for field use is being collected and tested.

Important Poultry Diseases in Nebraska. The investigation carried under this heading has been brought to completion and a summary setting forth the causes, nature, and prevention of the most important poultry diseases occurring in the State, has been made in Experiment Station Bulletin No. 195.

It was found that the frequency of diseases is to a large extent dependent upon the density of the livestock population; that there has been a steady increase in the diseases of domestic fowls as their numbers have increased upon the farm. Stress is laid upon the fact that the problem of poultry diseases will be more largely solved by preventive rather than curative measures and, as a means to this end, the following are mentioned: (1) Selection of sound breeding stock, (2) correct and adequate feeding methods, (3) sanitation, and (4) the eradication and control of transmissible diseases.

Relation of Avian (Poultry) Tuberculosis to Tuberculosis of Swine. This line of investigation has been actively pursued during the past fiscal year. Material of tuberculous swine of Nebraska origin was received from the South Omaha and Nebraska City packing establishments and a study was made of the type of bacilli responsible for the lesions. The laboratory examination of 26 consignments of tuberculous swine is now complete. In none of these could bacilli of mammalian origin be demonstrated, but in 21 of the specimens it could be quite definitely shown that the infection which gave rise to the lesions was caused by the avian strain.

Thru the co-operation of the local representatives of the U. S. Bureau of Animal Industry, it was possible to secure a complete survey of the animals on 14 of the farms from which the tuberculous swine originated. On all of those farms the poultry flocks were found to be infected with tuberculosis, but on only one were the cattle also found to suffer from this infection.

On 10 of those farms swine were also tested and on 5 those animals were found to be tuberculous. It is significant that many of those swine, tested simultaneously with mammalian and avian tuberculin, reacted only to the latter.

This project is far from complete, but the results thus far obtained warrant the prediction that the current views on the origin of swine tuberculosis will require thoro revision.

Other Animal Diseases. In addition to the above mentioned projects, a study has been made of such diseases as "Hog flu," abortion in swine, coccidiosis in sheep, but as yet this work is not sufficiently advanced to warrant a definite report on these subjects.

DAIRY HUSBANDRY

A Study of the Weight of Dairy Cattle. The purpose of this project is to determine the average gain in weight of both males and females of several breeds of dairy cattle.

All the calves are weighed at birth and for 3 days each week up to the time they are 6 months old, after which they are weighed for 3 consecutive days in the middle of each month. Males are weighed up to the time they are disposed of, while females will be weighed regularly as long as they remain in the herd. The following table gives the weight results obtained so far:

Breed	Sex	No.	Wt. 3 mo.	No.	Wt. 6 mo.	No.	Wt. 9 mo.	No.	Wt. 1 yr.
		<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>
Holstein	Male	19	91.3	17	217.0	13	434.3	9	632.8
Av. daily	gain				1.39		1.87		1.97
Holstein	Fem.	13	90.1	12	221.0	10	407.8	7	577.0
Av. daily	gain				1.44		1.74		1.78
Jersey	Male	5	55.4	3	137.2	3	274.0	2	444.0
Av. daily	gain				.90		1.19		1.41
Jersey	Fem.	11	49.9	10	118.5	8	263.1	6	380.8
Av. daily	gain				.75		1.16		1.39
Guernsey	Fem.	6	66.8	4	148.2	3	314.0	2	456.0
Av. daily	gain				.89		1.35		1.42
Ayrshire	Fem.	5	67.8	5	150.4	5	331.0	5	474.0
Av. daily	gain				.91		1.44		1.48

The Principles of Ice-Cream Making. During the year several phases were studied, including the acidity as affecting quality, yield, and viscosity; viscosity as regards the effect of aging; and comparative tests were conducted with different grades of gelatine.

Acidity Phase. Experimental mixes were made up with a composition approximately as follows: butterfat 14 per cent, sugar 14 per cent, gelatine $\frac{1}{2}$ per cent, milk solids-not-fat $7\frac{1}{2}$ per cent, or a total solids content of 36 per cent. The ingredients used as standardized cream were skim milk, skim milk powder, gelatine, sugar, and flavoring. The entire mix

was pasteurized at 145 degrees F. for 30 minutes, after which it was homogenized at a pressure between 2,000 and 2,500 pounds per square inch, and then cooled to 45 degrees F. Aging took place at temperatures between 40 and 45 degrees F. Experimental mixes were divided into 3 groups. Group I mixes were aged from 2 to 3 hours, Group II mixes from 19 to 48 hours, and Group III mixes for 72 hours. One-half of each group of mix was acidified by the addition of 15 per cent of a lactic acid skim milk starter. An equal amount of fresh skim milk was added to the check mix. Viscosity readings were made with a Scott's Viscometer, and overrun was determined by using a De Raef overrun tester. Hydrogen-ion concentration was determined on a Leeds and Northrup Type K Potentiometer. In brief the results so far indicate:

That the addition of the starter to the homogenized mix tends to increase viscosity.

Comparing results obtained from a mix of high viscosity due to acidity and aging, with those from the check having a lower viscosity, aged the same length of time but of lower acidity, no decided differences were apparent in the yield of ice cream during the freezing process.

No change was apparent in the hydrogen-ion (P H) value of normally handled ice cream mix during aging varying from 3 to 45 hours.

The frozen cream from acidified mixes tends to retain the lactic acid flavor of the starter and is consequently objectionable.

Since acidity is objectionable in frozen cream and does not noticeably affect the physical make-up during the aging and freezing of the mix, it serves no useful purpose and is not to be recommended.

The Effect of Aging on Viscosity and Texture of the Ice Cream Mix. The influence of aging upon viscosity and texture was studied with 8 emulsified and 24 homogenized batches. Samples were taken from each batch immediately after preparation and before aging and kept in the aging room. Viscosity readings were made at intervals ranging from 2 to 72 hours and microscopical examinations were made at the same time. The results so far indicate:

That excessive aging tends to decrease the viscosity of the mix and cause a decrease in its ability to preserve a smooth texture.

That homogenized mixes appear always to have a higher viscosity than emulsified mixes, both before and after aging.

That the optimum aging period for a normal mix is between 24 and 48 hours.

Study of Gelatine. It is believed that the foremost functions of gelatine in an ice cream mix are to prevent the crystallization of the sugar and the formation of large ice crystals. With this in mind the following test has been worked out, which it is believed will indicate the effectiveness of different grades of gelatine for the purposes mentioned.

A "gel" is prepared from 4 grams and 120 c. c. of distilled water, to which is added 12 grams of bichromate ($K_2Cr_2O_7$). After the gelatine and bichromate are dissolved, a test tube is filled half full and set away to congeal. After congealing, 5 c. c. of an $8\frac{1}{2}$ per cent silver nitrate solution ($AgNO_3$) are poured on top of the "gel." The tube is allowed to stand for 24 hours. A comparison of different grades of gelatine can then be made, one "gel" being made for each grade. The sample that exhibits the greatest amount of brick red stratification appears to have the greatest protective powers. Microscopical examination of the crystallization that took place in 5 per cent milk sugar (lactos) solution containing 1 per cent of gelatine of different grades shows a co-ordination between stratification and a compact, smooth form of crystals.

NATIONAL EGG LAYING CONTEST

A total of 272 birds trapnested in the Egg Laying Contest have made records of 200 eggs and better. These birds have been returned to their owners and are being used in breeding pens for the development of better laying strains of poultry. The publicity which the breeders of these birds have given their records has helped to emphasize the importance of egg production, on which the development of the poultry business depends.

The egg records of birds at the Egg Laying Contest have varied all the way from 2 to 275 eggs. These birds were all housed in the same kind of houses and had exactly the same feed and opportunity to produce. The average production of all birds finishing the contest each year has been better than 150 eggs per bird, which is approximately twice the average for the whole state.

The number of hens making records of 200 eggs or better each year is as follows:

1919-20—33 birds
1920-21—76 birds
1921-22—77 birds
1922-23—86 birds

Birds representing nearly every breed and variety of standard bred poultry are included in the list. A breeding program which is based on the use of the best layers in each entry is being carried out by most of the breeders.

Trapnesting during at least a part of each year is now also being practiced by an increasing number of breeders who are wanting more accurate information on the laying ability of their birds than the physical characteristics tests give them. A study of the trapnest records made at the laying contests shows that intensity of production for at least 2 successive months quite accurately measures egg-laying ability. Hens which have laid 50 eggs in any successive 60-day period are usually the outstanding individuals judged by one-year records. Annual records are of course more desirable but more costly because of the labor required.

FIELD CROPS AND SOILS

Corn Breeding. This project has been carried for a number of years, the purpose being to determine methods for improvement in the yield and quality of corn and to establish general principles of corn breeding.

Many of the proposed earlier methods of corn improvement, such as the detasseling and ear-to-row methods, have failed to produce beneficial results. The favorable hybridization of pure lines that have been reduced to a homozygous state by prolonged inbreeding seems now to be the most promising procedure for corn improvement. Certain pure line first generation hybrids have indicated superiority over the original corn but new hybrid seed must be produced each year rather than to select from the hybrid progeny. Very material reduction in yield has resulted in all cases where the seed was selected from the first year cross. Investigations are under way to determine the possibility of weeding out undesirable characters by inbreeding and then recombining a relatively large number of pure line selections in order to obtain a corn that will continue to give relatively high yields. In this study many combinations are being made.

Fertilization by foreign pollen has failed to give a material increase in kernel weight of commercial varieties of dent corn. The increase from heterosis is very marked in the case of selfed strains, amounting in these tests to an average of 11.8 per cent. The increase due to a change in endosperm type which occurs with sweet corn when fertilized by a starchy type is also marked, amounting to an average of 19.9 per cent for 6 sweet-dent combinations.

Seed corn from various sources and germinator selections for freedom from root rot diseases confirmed earlier indications that these rot diseases are not serious in Nebraska and that nothing is to be gained by such germinator testing for disease provided usual precautions are taken to select seed of satisfactory viability. The question of regional adaptedness is involved in all such tests and is regarded the outstanding factor in relative productivity.

An Experiment Station Bulletin, No. 188, entitled "Productive Seed Corn," was issued in April, 1923, and summarizes many of the problems under consideration. Additional data are reported in Vol. 15, No. 5, and Vol. 16, No. 1, of the Journal of the American Society of Agronomy.

Water Requirement of Crops. This work was continued with some 400 potometers, the purpose being to study correlations between the use of water of the corn plant in relation to climatic factors, soil fertility, variety, plant characteristics, and source of seed. Homozygous inbred strains were also compared with their hybrids.

Increasing the concentration of the soil solution thru the addition of various rates of either manure or artificial fertilizer has failed to reduce the total amount of water used per corn plant during its growth to maturity. On the other hand, the amount of water transpired per pound of dry matter has decreased somewhat with such applications until a point is reached where the added fertility results in decreased yields.

Concerning 8 standard varieties of field corn during a 7-year period representing types adapted to various regions, the extreme range of water transpired per pound of dry matter was 260 pounds for a variety obtained from New York and 279 pounds for a small early maturing variety from South Dakota. The total water used per plant for these same 2 varieties averaged 235 and 135 pounds, respectively. In comparison with these the variety known as Esperanza, which is not grown commercially, was extreme in the amount of water used per pound of dry matter,—namely, 317 pounds.

The water requirement per pound of dry matter has varied for corn grown under similar soil and moisture conditions during the 13-year period, 1910-1922, from 192 pounds in 1915 to 445 pounds in 1913; 218 pounds were used per pound of dry matter in 1922. The variation from year to year has been found to correlate rather closely with the evaporation rate from a free water surface, which in turn varies with the seasonal climatic conditions.

The transpiration data as a whole suggest that any soil treatments which result in more favorable plant development tend to increase the dry matter produced per unit of water transpired.

Small Grain. This work was continued in the study of variety testing, breeding, acclimatization, and cultural studies with various small grains.

The outstanding factor in the oat production is the relative yields of early and late varieties. A summarization of 18 years of work, 1905 to 1923, shows that the 3 leading early varieties,—Kherson, Texas Red, and Burt,—have given an average of 54 bushels per acre. The 4 most promising late varieties,—Swedish Select, American Banner, University No. 6 (Minnesota), and Lincoln,—have averaged 45.3 bushels, or an average of 8.7 bushels per acre in favor of the earlier varieties of oats. This difference in yield is not as wide as has been found between the early and late varieties at the North Platte Station, indicating that earliness is even more important as one goes westward in the State, except where it is grown under irrigation. Several selections of Kherson have continued to give higher yields than the original strain. One of these, Nebraska 21, is now widely distributed thru the State. The work in the improvement of Texas Red and Burt varieties has been continued. Commercially these varieties are mixed in color and a number of strains true to color of grain, ranging from black to white, have been selected. Four hundred pure line strains of the original 1,200 selected were grown this year.

Early Java and Marquis spring wheat have continued to give the highest yields among the varieties of common spring wheat tested. Kota has been inferior under our conditions; while Acme and Monad Durum yielded highest of all spring wheat varieties. The last 2 named have been declared inferior and undesirable in quality by the U. S. Department of Agriculture.

Winter wheat varieties of the hard winter type have very definitely outyielded those of the soft to semi-hard winter types. Kanred, Nebraska No. 6, and Nebraska No. 60 have surpassed all sorts commercially available, tho strains from several other sources have given about equal results. Kanred is unsurpassed as an all-round wheat. Blackhull gives indications of lacking winter hardiness this far north. Chemical analyses indicate that some of the Turkey Red strains are fully equal to the original Turkey Red in protein as well as being high in yield.

The testing of a large number of Crimean selections has continued in the nursery. Special effort will be made to select for resistance to disease and winter killing.

Delay in planting winter wheat after October 1 results in receding grain yields as the delay is extended. Winter wheat planted under conditions of delayed germination so that growth does not begin until spring has its yield greatly impaired irrespective of the character of winter weather in this section of the State. Early planting has proved equally important with oats and spring wheat.

Rate-of-planting tests indicate there may be a wide diversity in planting rate with any of the small grain crops without material effect upon yield.

Forage Crop Investigations. Annual forage crop investigations consisted largely of varietal studies of the sorghums, millets, and other annual crops adapted to Nebraska conditions and of cultural studies of ordinary amber sorghum and sudan grass.

During a 4-year period amber sorghum yielded 5.15 tons per acre, whereas sudan grass yielded 3.31 tons, or 64.3 per cent of the sorghum yield. Of the 10 sorghums grown in the variety tests there has not been much difference in tonnage per acre when sudan grass is excluded. Black amber was found to be one of the earliest maturing and best yielders of the group. During especially long growing seasons later varieties, as Red Amber, Orange, Sumac, and Honey, may yield more than Black Amber. German Millet was the highest yielding foxtail millet and has yielded 79 per cent as much as ordinary amber sorghum. Japanese barnyard and Pearl millets have given satisfactory yields, but have been later maturing and the forage produced has been coarser and less palatable.

Six dates of seeding amber sorghum and sudan grass, ranging from May 15 to July 5, have been practiced. The first 4 seedings have given but little difference in yield. Based on the average yields from the first 4 dates, the fifth and sixth dates of seeding amber sorghums have yielded only 74 and 58 per cent of the earlier dates and for sudan grass 71 and 51 per cent. Amber sorghum seeded at 6 rates, varying from 25 to 150 pounds per acre, has given relative yields of 100, 110, 107, 111, 116, and 115, based on the thinnest rate as 100 per cent. Similar results for sudan grass seeded from 10 to 80 pounds per acre have been 100, 96, 103, 106, 108, and 110. Harvesting at 3 stages of maturity have been followed for both crops,—i. e., heads appearing, fully headed, fully

ripe. Based on the first stage as 100, the yields for the sorghum have been 100, 108, and 113 and for the sudan grass 100, 112, and 89. Amber sorghums drilled, broadcast, surface planted in rows, and listed have yielded 100, 85, 67, and 49 respectively, based on 100 per cent for the drilled. Similar yields for sudan grass have been 100, 90, 82, and 67.

Three years' results have been secured from studies dealing with cultivation, application of fertilizers to, and dates of harvesting of alfalfa. The evidence obtained is not yet sufficient to justify conclusions. An exhaustive study of alfalfa varieties and regional strains is under way; also a study of date of seeding, rate of seeding, and time of harvesting of sweet clovers and a study of the more important perennial grasses and red clovers.

Soil Fertility. The work at the main station has been continued at the Agronomy Farm. These experiments have been in progress for only 3 years and have not run long enough to allow definite statements of results. Applications of manure have given small but consistent yields on all crops. The largest increase on wheat and oats comes from the heaviest application of manure and in the year following its application. With corn the largest increase comes the second year after application. Applications of phosphorus show in the early growth of oats and wheat but have failed to give consistent increased yield at harvest.

The effect of applications of nitrogen on oats and wheat is seasonal. Small increases have been obtained in seasons unfavorable for the development of nitrates in the soil. No commercial fertilizer has given consistent increases of corn. The yields of alfalfa have declined each year since the first year's crop. Applications of manure, lime, and various commercial fertilizers have failed to increase yields, which indicates that on this soil the yield is determined largely by the moisture supply and not by fertility. After alfalfa has been grown for a term of years the supply of moisture in the sub-soil becomes exhausted and the crop is entirely dependent upon rainfall.

Co-operative Experiments. Work has been continued in co-operation with farmers in the State. The plan has been to carry these co-operative experiments 3 years in a county, on all of the important soil types. The experiments are limited to a study of the effects of manure, acid phosphate, and potassium chloride on wheat, corn, and oats. During the past year, work was carried on in Washington and Gage

Counties. Up to the present no soil types have been found which are so deficient in nitrogen, phosphorus, or potash that these elements can be supplied economically as commercial fertilizers.

Factors Influencing Nitrification in Nebraska Soils. The purpose of this project is to determine the importance of moisture, temperature, aeration, and organic matter on the rate of nitrate accumulation in the soil and to establish a rational basis for systems of tillage, rotation, and soil improvement with respect to nitrate elaboration.

Laboratory studies on average soil from the Agronomy Farm have shown that the rate of nitrate accumulation under temperature conditions that might obtain from late fall to May 15 is not sufficiently high to meet the needs of wheat or oats, but the rate at which nitrate accumulates at summer temperature is sufficiently high to meet the demands of the corn plant. The limited moisture conditions that obtain during the large part of the seed-bed preparation season for wheat also seriously reduce nitrate accumulation. Laboratory studies show that aeration is probably not a serious factor in nitrification under Nebraska conditions. The most important development of laboratory studies has been the very low rate of nitrate accumulation on soils which have been depleted of their organic matter. Correlations between crop performance in the field and nitrate production in the field and incubator indicate that there may be soils in Nebraska which have been so depleted of organic matter and nitrifiable material, either by erosion or by long continued grain farming, that nitrate production is the limiting factor for wheat and oats.

Soil Acidity. The purpose of these investigations was to determine the approximate extent of acid soils in Nebraska, whether or not the problem at present had serious aspects, and the probable cause for acidity under Nebraska conditions.

During the past season the work on the samples obtained from the fields has been completed. In all more than 550 samples of soil were collected from more than 160 areas. The information obtained shows that acid soils are more widely distributed thru Nebraska than was commonly thought. The Drift Hill region in southeastern Nebraska is the most acid region. The Shelby and Carrington loam types in Johnson, Pawnee, and Gage Counties are the most seriously acid soils in the State. The Loess Hills soils are very slightly to medium acid, depending upon the extent to which erosion has laid

bare the underlying calcareous subsoil. The Loess Plains soils grow less acid and the calcareous horizon in the soil comes closer to the surface as rainfall decreases westward across the state.

The acidity found in Nebraska is due to leaching. Rain water carbonated by organic decay leaches the lime out of the surface soil, carrying it to a lower depth. The factors determining acidity are rainfall, original supply of carbonates, age of the soil information, the extent of percolation as determined by texture and structure, and extent of vegetable decay both in the virgin state or under cultivation.

Ninety-five per cent of the samples collected for this study showed less than medium acidity by the Truog method. A few samples gave strong reaction, indicating strong acidity. The lime requirement of the most strongly acid soils is not higher than 3,360 and 760 pounds calcium carbonate per acre, by the Veitch and Hopkins methods, respectively.

FRUIT PRODUCTION

Winter Injury Investigations. The purpose of this investigation was to determine the effect of low soil temperatures on root injury of the apple. Investigations have been under way since 1915 and are being summarized for publication, the following conclusions having been made:

Individual French crab seedling stock is rather easily injured by severe winter temperatures. Many of them will be killed or severely injured by an exposure of -10° C. for two hours in an air chamber.

Scion roots of most varieties are hardier than French Crab and seedling roots.

Small, young roots are more susceptible to cold than large, older ones.

Varieties of apples differ in their tendency to form roots from scion wood. Scion roots are produced by some the first year in the nursery, while others have none at the end of the third year.

The tops of some varieties are more subject to winter injury in the nursery than others.

Apple twigs taken in late winter became calloused readily, but they did not form any roots.

At $7\frac{1}{2}$ inches depth the temperature under bluegrass sod was from 2 to 7 degrees C. higher in midwinter than that in a clean cultivated plat.

Moisture content of orchard soil used did not greatly influence the minimum temperature that was reached in mid-winter at several inches below the surface. The dry soil, however, responded more quickly than the wet one to atmospheric changes. Freezing temperatures were reached somewhat sooner in early winter in the dry than in the wet soil. In early spring the wet soil remained at or near the freezing point for 12 days while the dry soil had a mean temperature of 34 degrees F.

If there is less injury to roots in a wet than in a dry soil, it is probably due to protection afforded by the moist medium and not to higher soil temperatures in the region of the roots.

Occasionally in midwinter soil temperature of eastern Nebraska gets low enough to kill tender apple roots to a depth of 6 to 12 inches.

Pruning Apples, Grapes, and Small Fruits. This study is undertaken to determine the influence of different methods of pruning upon the fruitfulness and growth of the plant. With apples, work is being done on the "filler" trees at the Union Orchard and includes a study of several pruning methods; also the effect of light and heavy pruning during both the growing and the dormant season. These trees are just beginning to bear, and data on the relation of different methods of pruning to yield are not available.

Pruning experiments with grapes are being conducted to determine the relative merits of the "cane renewal" system as compared to the "spur renewal" system. A portion of the vines are trained to a single trunk and the remainder to a double trunk.

Fifty-three plants were pruned to the cane system and 61 to the spur system. The cane pruned plants had an average of 96.6 buds per plant, in 1923, and produced 6,983.2 grams of fruit. The spur pruned plants had an average of 62.1 buds per plant and produced 5,974.2 grams of fruit. There was a difference noted in the two plats in the percentage of buds that produced fruit, in the number of clusters produced, and in the size of the clusters. There were 73.94 per cent buds on the cane pruned plants which were productive, while only 66.6 per cent of those on the spur pruned produced fruit clusters. The number of clusters from each producing bud on the cane pruned plants was 2.53, while the number on the spur pruned plants was only 2.26. The average size of clusters from the cane pruned plants was 62.64 grams and from the spur pruned plants 60.99 grams. It

should be remembered that these vines are only 7 years old and are therefore very vigorous.

Fruit Breeding Investigations. In these investigations 762 new strains of strawberries were produced by crossing and inbreeding a named variety. Ten of the hybrids have been retained after 7 years' testing. These promising hybrids have been selected largely upon their ability to outyield Dunlap, the standard variety for this section. They also produce larger berries thruout the season than either Dunlap or Warfield. Bulletin No. 189 summarizes this work.

INSECT CONTROL

Life History of Several Common Cutworms. Work on this project for the past year was confined largely to gathering additional material on the Western Army Cutworm.

Control of Injurious Insects, Mammals, and Birds. During the past year the work along this line was confined largely to a study of the Plains False Wireworm (*Eleodes opaca*). This worm seriously attacked the wheat crop of 1922-23 in several counties in western Nebraska. Experiment Station Circular No. 20 gives the life history and proposed control of this worm.

Reports on the gadflies of Nebraska, an important group of insect pests of livestock, and upon the syrphus flies, a group that contains a number of useful enemies of aphids, were completed during the period covered by this report and have recently been printed. A report was also completed on the June-beetle family, which contains the very injurious white grub and its relatives, and this report has also just been published.

Grasshopper Control. This project has received considerable attention during the past season. Field experiments were conducted at the Scottsbluff Station from June 13 to August 17, 1922, and the results obtained were summarized in Bulletin No. 183, on "Experiments with Poisoned Baits for Grasshoppers." This work also formed the basis for the working out of a formula for preparing poisoned baits for use against grasshoppers in the North Platte valley, where these pests have been quite injurious for a number of years. Efforts to improve this formula were continued during the summer of 1923 and the further results obtained will be summarized in a bulletin now in course of preparation.

Hessian Fly. Considerable damage was done by the Hessian Fly during the past year. An increasing number of flies have been noticed for the past two or three years. The fall brood of 1922, favored by the dryness of the season, developed more widespread infestation. A survey in the spring of 1923 showed Hessian Fly present in all counties south of the Platte River and west to Frontier and Red Willow Counties and north of the Platte to Dakota, Wayne, Madison, Boone, Howard, Sherman, Buffalo, and Dawson Counties. Serious injury was done to the 1923 crop in a number of sections. Realizing that the large number of Hessian flies present in 1923 were likely to cause large and unnecessary losses to the following crop, a field observation station was established in the heart of a heavily infested district along the Missouri River, in order to determine from observations made at this point the safe date for planting wheat.

The most satisfactory known method of combating the Hessian Fly has been to delay seeding of the winter wheat until the danger of fly infestation in the field has passed; and in a number of sections where the damage has been heavy in 1923, the farmers agreed to delay seeding until the observations showed that the danger of infestation had passed, when the County Agent would be notified and he in turn would notify them.

Arrangements were made to make daily counts of the emergence of the adult flies, their movement in the field, their egg-laying, and the decreasing presence of the viable or living puparia in the stubble. The daily emergency of the adult flies was determined by the flies emerging from about 3 bushels of heavily infested stubble placed in a tight wooden box. The daily movement of the flies in the field was measured by counting the flies caught on two large wire screens set up in the stubble field and painted with a sticky preparation. The egg-laying each day was measured by the number of eggs laid on 100 wheat plants, selected in a small plot of wheat, which was seeded on August 20. The decreasing presence of viable puparia in the stubble was determined by counting and examining the puparia contained in 100 old stubble plants each day. The observations made showed varying but large activity of the flies along the several lines included in the studies, the activity increasing rapidly toward the first of October.

On September 29, when the date of safe seeding for Cass County was noted to be almost at hand, the date of safe seeding for Douglas, Saunders, Colfax, and Buffalo Counties was announced for that day; then when it was announced for

Cass County on October 1, it was also announced for Seward and Fillmore Counties; for Otoe County the date of October 2 was announced; for Johnson and Furnas Counties, October 3; and for Richardson County, October 3. The co-operating county agents immediately notified the farmers in their counties that it was now safe to go ahead and seed the winter wheat as rapidly as possible without any fear of injury to it by the Hessian Fly.

The results of seeding on the announced safe dates have been checked up in several counties, from data secured in co-operation with the Federal Bureau of Entomology Laboratory at Wichita, Kansas. In Cass County wheat seeded September 17 was 27 per cent infested; that sown on September 24 was 24 per cent infested; while that sown on October 1, 8, and 15 was absolutely free from infestation. In Richardson County, wheat seeded September 24 was 72 per cent infested; that sown October 1 was 16 per cent infested; while that sown on October 6 and 10 was absolutely free from infestation. In Fillmore County, wheat seeded September 19 was 19 per cent infested; that sown September 24 and 26 was 2 per cent infested, while that sown on October 1 and 8 was absolutely free from infestation. In Furnas County wheat seeded on September 29 and on October 2 and 8 was absolutely free from infestation. The co-operation of the farmers in the various counties varied from 70 per cent not seeding their wheat until on or after the announced date of safe seeding, up to 95 per cent in Cass and Richardson Counties awaiting the safe date of seeding. As a result, Hessian Fly damage in the co-operating counties was relatively unimportant during the fall of 1923, while the counties that were not badly enough injured in the fall of 1922 and spring of 1923 to be interested in the campaign became the more heavily infested counties in the fall of 1923.

LIVESTOCK FEEDING

Beef Cattle. Effect of age upon rate and economy of gain. Four lots of 10 steers each, ranging in age from calves to 3 or 4-year-olds, inclusive, were put on feed October 31, 1922. The cattle were all of the same breed and were similar in quality. They were purchased from the Young ranch near Valentine, Nebraska. Each lot was fed for a period of 200 days upon a ration of shelled corn and alfalfa hay.

The results concur closely with those secured in the 2 previous trials. All groups gained slightly over $2\frac{1}{2}$ pounds per day. The calves consumed much less feed than the older

cattle and made much more economical gains. They, likewise, gained consistently thruout the period, while the older cattle gained rapidly at first and very slowly toward the close of the period.

Baby Beef. Beginning November 17, 1922, six groups each containing 16 calves were fed for 175 days at the Experimental Agronomy Farm, near Lincoln. The objects were to ascertain the advantages of using various rations; also to compare steer and heifer calves.

Shelled corn and alfalfa hay proved to be the cheapest and most profitable ration used. The addition of 1.1 pounds of linseed oil meal daily increased the gain and selling price, but decreased the profit. Oats returned a value below existing market price. Ground corn did not produce the finish that shelled corn did.

Heifers gained more slowly than steers and sold for lower price, hence showed less profit.

Rations for Fattening Lambs. Ten lots of 30 lambs each were fed for 84 days commencing October 17, 1922. Various rations were used, shelled corn and alfalfa proving to be the most profitable. The addition of linseed meal in varying quantities increased the daily gain and cost of gain, with resultant lower profit. Adding cottonseed meal gave the greatest gain, but, likewise, it was the most expensive. Using prairie hay instead of alfalfa hay, with corn and oil meal, lowered the rate of gain, increased the cost, and resulted in this being the lowest profit lot.

Rations for Fattening Hogs. Beginning February 13, 1923, six groups of fall shoters averaging 110 pounds were fed for 70 days. There were 15 hogs per lot.

Yellow corn and tankage gave better results than either white or mixed corn and tankage. Three hundred and seventy-one pounds of yellow corn and 41 pounds of tankage produced 100 pounds gain, while 393 pounds of white corn and 52 pounds of tankage were required to produce the same gain. It required 383 pounds of mixed corn and 51 pounds of tankage to produce 100 pounds gain. Ground barley and tankage produced the highest daily gains, but the most expensive gains, because of feed necessary to produce 100 pounds gain. It required 454 pounds of ground barley and 50 pounds of tankage.

The cost of 100 pounds gain with ground barley was \$7.56, with yellow corn \$6.16, with white corn \$6.84, and with mixed corn \$6.70.

Beginning October 25, 1922, six lots of twelve pigs each were fed for 76 days. These pigs were raised on the United States Experimental Farm at McNeil, Mississippi, and shipped to Lincoln for fattening.

The trial consisted of a comparison of yellow and white corn. Yellow corn produced an average daily gain of 1.47 pounds, while white corn produced 1.36 pounds. To produce 100 pounds gain with yellow corn, 3.88 pounds of corn and 1.05 of tankage were consumed. With white corn it required 4.29 pounds of corn and 1.01 of tankage. On yellow corn the feed cost of 100 pounds gain was \$6.25 and on white corn \$6.45.

Feed from Pasture. Work was commenced in the spring of 1923 in testing the efficiency of sweet clover as pasture for dairy cattle. Only a limited amount of data has been secured and the work is being continued.

During the past year some work was done in a comparison of sudan grass and sweet clover as pasturage for beef cattle on full feed of corn. In this season's work the sudan grass showed up very favorably in comparison with the sweet clover and the work will be continued to obtain further evidence.

MILLING AND BAKING QUALITIES OF WHEAT

A survey of the Nebraska wheat crop of 1922, with respect to chemical composition and baking quality, has been completed and the results tabulated and interpreted. This survey included milling, baking, and chemical analyses of 112 samples of known origin and from different parts of the State. Samples are collected for a similar survey of the 1923 crop.

From the material used in the survey of the 1922 crop were selected 9 or 10 samples showing widely different characteristics. These were subjected to a wide variety of chemical and physical-chemical tests, in an effort to find any possible relationships between baking quality and chemical properties. Nearly all of these tests resulted in negative correlations. A fairly close correlation between baking quality and water soluble ash was noted, however, the higher baking qualities being associated with the higher percentages of water soluble ash.

Since the viscosities of acidified flour and water suspensions have been recently suggested as a valuable index to the colloidal properties of flour, and, since gluten quality is frequently said to be dependent on colloidal property, this de-

partment has made and is making a rather detailed study of the relation of the baking qualities of Nebraska wheat flours to viscosities of their acidified suspensions in water. Enough evidence has been obtained to warrant the conclusion that for Nebraska wheats such relationship exists only within limited groups of samples grown under the same (or at least very similar) environmental conditions. Furthermore, we have noted a number of exceptions to the idea that high baking quality is necessarily associated with high viscosity in the acidified flour and water suspension.

Individual proteins are being prepared from flours of widely different baking qualities, with a view to comparing some of their chemical and physical properties.

Studies are in progress which have to do with the effect of aging on certain chemical and physical properties of wheat and flour.

* NUTRITION

Nutrient Requirements of Growing Chicks. This project undertakes to determine the effect of environmental conditions,—especially the influence of sunlight, on the prevention and cure of rickets in chicks.

It is observed that chicks on a standard ration that are exposed for an average of less than an hour daily to direct unfiltered sunlight are developing normally, whereas chicks exposed to sunlight which has passed thru common window glass develop rachitic symptoms.

It is supposed that the ultra-violet rays, which are filtered out when sunlight passes thru common glass, are the active agents which influence calcium and phosphorous assimilation.

Comparative Efficiency of Various Proteins in Poultry Feeding. This is a study of the actual nitrogen retention when various proteins are fed at varying planes of intake to chickens. The nitrogen retention is established by determining the nitrogen elimination on a nitrogen free diet and applying this figure as a correlation to the figure obtained from the determination of total nitrogen elimination when known amounts of protein are fed.

A considerable amount of data bearing on the nitrogen elimination of chickens on a nitrogen free diet have been published in a preliminary paper entitled "The Endogenous Metabolism of Hens and Capons," which was recently published in "Poultry Science." Data are now accumulating with reference to nitrogen retention when the source of nitrogen is restricted to the proteins of corn.

Studies of Fat Soluble A Present in the Milk of Different Dairy Breeds. The purpose of this investigation is to determine whether or not Fat Soluble A is present and to the same amount in the milk of the principal dairy breeds, including Holstein, Jersey, Guernsey, and Ayrshire.

The method involves the development of a considerable colony of rats of the same breeding, which will have received for some time a basal ration in which Fat Soluble A is absent. When the weight growth of these rats shows that the Fat Soluble A in the body has been utilized and the weight is decreasing, then different pens of rats will be fed the milk from the different dairy breeds and in varying amounts, in order to determine not only the presence of Fat Soluble A in the milk, but the quantity of milk to give sufficient Fat Soluble A so that the rats will resume normal growth. The work has not yet progressed sufficiently for a report to be made.

PLANT DISEASES

Studies of Stem Rust. This project is a study of the environmental conditions influencing the development of stem rust of wheat in the absence of the barberry. During the past 2 years a detailed study of 2 biologic forms of *Puccinia graminis tritici* was undertaken to determine whether or not their reaction on the differential hosts remained consistent under various environmental factors. At the same time the influence of environmental conditions on the growth of the differential hosts and on the disease was determined.

The factors controlled in this investigation were soil temperature, soil moisture, air temperature, and relative humidity. Sunlight was a variable factor, but the total hours of sunlight was recorded during the experiments.

It was found that the general type of infection of a biologic form on a differential host could not be changed: 1, by any of the environmental factors to which the differential host and biologic form were submitted; 2, by the source of the inoculum; or 3, by the source of the seed of the differential hosts.

The differential hosts at the various stages of growth from seedling to heading occurred at 15° and 20° C. Temperatures of 10° below resulted in a slow growth, while temperatures of 25° and 30° C. inhibited the growth of the plants. The optimum temperature for the development of the disease at all stages of growth was between 20° and 25° C. In general it might be said that the temperatures at which the plants

make their best growth are generally the same as those at which the best development of the disease takes place.

A progress report of this phase of the project has been published as Research Bulletin No. 25 of the Agricultural Experiment Station.

Fusarium Wilt and Stem-End Rot of Potato. *Fusarium eumartii* is the cause of potato wilt and stem-end rot in Nebraska. The disease causes a reduction in germination, an increase in the number of barren plants, and a high percentage of stem-end rotted tubers. Infection occurs chiefly from the soil rather than from the seed. Infected seed does result in an increase of disease due to seed rotting in the ground and the production of weak plants more susceptible to infection from the soil, either thru roots or seed piece. The organism produces a toxic substance, capable of killing the host tissue in advance of the organism. The optimum temperature for the disease is 20°-24° C. Soil moistures favorable for the host are favorable for infection. After infection occurs, wilting is favored by low soil moisture, while tuber infection is favored by increased moisture. The only practical control is the prevention of the disease by use of healthy seed and long rotations.

Effect of Environment on Potato Degeneration Diseases. The mosaic diseases of potatoes result in decreased yields with all forms of the disease but only slightly with "mild mosaic." Combinations of mosaic and spindle tuber cause the most serious losses.

Mosaic symptoms are masked at mean temperatures above 70° F., and are increasingly evident as the temperature drops. The effect of temperature decreases with the age of the plant and the severity of the disease. High sunlight intensities and low moisture are also correlated with the masking of symptoms. Such masking makes it impossible to determine the amount of disease present in the fields under certain conditions often present in Nebraska. This is probably a greater factor than insect transmission in the yearly increase of the disease. The planting of representative samples of all certified seed under conditions favorable for the disease is necessary in making estimates of the amount of disease present.

POTATOES

Potato Selection. This project has been continued since 1919. Some of the results secured during the first 3 years have been presented in Experiment Station Bulletin 182. This

work is being conducted at the several State Stations and on the farms of a number of co-operators. It has included a study of several of the most promising varieties under different conditions in Nebraska. A large number of strains of most of these varieties have been planted for comparative trial purposes for the purpose of determining the variation existing within varieties and to determine to what extent the various diseases are prevalent in Nebraska seed stocks. During the 1923 season approximately 110 lots of potatoes were assembled from that many growers in western Nebraska. These lots were grown in comparative trial plats. The results secured show that some farmers were planting potatoes which produced as low as 15 bushels per acre of U. S. No. 1 grade potatoes, whereas other farmers were raising potatoes of the same varieties which were capable of producing practically 400 bushels per acre of the same potatoes under the same growing conditions. The importance of developing some means of eliminating these poor strains and replacing them with the superior strains is quite apparent. Similar trials were conducted during the past years on a less extensive scale but with similar results.

Seed Potato Certification. In view of these great differences found in various lots of potatoes during the period that this project has been in force, a system of seed potato inspection and certification has been developed for the purpose of locating the best lots of seed and organizing a system of procedure to encourage the improvement of these better lots. During the past year 121 fields of potatoes with an area of 2,419 acres and a production of approximately 200,000 bushels of marketable potatoes were certified for seed purposes.

During a 5-year period, which was concluded in the summer of 1923, thru co-operation with the Bureau of Plant Industry and Experiment Stations located in 4 southern states, co-operative tests have been conducted of certified seed potatoes grown in this state as well as in other states which produce Triumph seed potatoes. In all of these southern trial plats the Nebraska lots of potatoes have consistently been quite superior. A very extensive demand now exists in all of the Gulf Coast states for western Nebraska certified seed potatoes, largely because of their relative freedom from the mosaic disease, which is one of the most serious factors affecting the early Triumph potato industry in the south.

During the 1923 season potatoes from every lot of potatoes which was certified in Nebraska were planted in a trial plat at the Louisiana Experiment Station for the purpose of de-

termining the efficiency of the certification service and to supply advance information which would be of value during the current season in Nebraska. A similar comparative trial plat was planted at an early date in western Nebraska. This feature of the work is being continued in 1924. By this means the certification work is considerably strengthened.

The effect of the size of seed piece and distance of planting under various climatic conditions is also under study.

Degeneracy in Potatoes. Summarization of some of the work done so far on this subject is presented in Experiment Station Research Bulletin No. 24. The conclusions that have been drawn are as follows:

The soil and climatic conditions in the high altitude region of western Nebraska are suitable for the production and perpetuation of high-yielding seed potatoes.

Tuber line studies with numerous lots of different varieties revealed early and late maturing strains as well as a type of degeneracy very similar to, or identical with, "spindling tuber" (recently described by Schulz and Folsom). This degeneracy manifests itself by a stiff, upright habit of growth and by an elongation of the tubers. Strains affected by it never recover, but become progressively weaker.

The degeneracy most common in western Nebraska is perpetuated thru the tubers and appears to be transmitted from plant to plant in the field.

Irrigation produces conditions more conducive to the rapid increase of this degeneracy than dry land culture, the per cent of the degeneracy increasing and the yield decreasing with each additional year of irrigation.

This type of degeneracy has been studied in 10 different varieties.

Many lots from isolated fields in the newer dry land potato growing sections are relatively free from this degeneracy.

This type of degeneracy causes very serious decrease in tuber yields till eventually no marketable tubers are produced.

Seed stocks produced on dry land at the highest altitudes proved to be superior in point of quality and yield of tubers produced, when planted in comparative trials.

RURAL ECONOMICS

Farm Management Survey. The principal study involved in this project is the effect of diversity of business on labor income. During the past year about 80 additional farm records were obtained from Scotts Bluff County.

Cost of Producing Beef Cattle. This project is co-operative between the College and the U. S. Department of Agriculture and 4 years' work has now been obtained. The data are obtained direct from farmers upon cattle fed in the usual manner. A final report is expected within the present year.

Farm Tenure. This work is carried on as a survey in several rural communities. During the past year the following publications have been made:

- Bulletin 180, Reading Matter in Nebraska Farm Homes.
- Bulletin 185, The Nebraska Farm Family.
- Bulletin 191, Nebraska Farm Homes.
- Bulletin 196, Nebraska Farm Tenancy.

Cost of Production of Farm Crops. This work is conducted in co-operation with the farmers. Record blanks are furnished on which the farmers keep an accurate record of the costs of producing the various farm crops. The attempt is to obtain the number of hours of both horse and man labor, rather than the value of the labor.

Purchasing Power of Nebraska Grains. During the past year Bulletin 187 was issued on this subject. In this bulletin is considered the relative purchasing power of wheat, corn, and oats, at a given point in Nebraska for the past 45 years. The basic purchasing power was taken as the year 1913. Another manuscript on factors affecting the price of farm products is almost complete.

Farm Land Problem. This project is being carried in co-operation with the U. S. Department of Agriculture. During the past year the gathering of basic data on land price was practically completed. Further investigation on farm mortgages and taxation is being carried forward.

SERUM PRODUCTION

The same policy of buying and retesting serum that has been practiced for the past 2 or 3 years has been continued, as it has proved to be very satisfactory. The demand for serum from the State Serum Plant has been very heavy during the late summer and early fall months, but all orders were filled promptly and a sufficient reserve was on hand at all times. All virus put out by the State Serum Plant was produced by it with the exception of a small quantity which was purchased to meet a rather sudden heavy demand. Particular pains have been taken with the virus produced, in order that

a pure, fresh, virulent virus may be sent out, as that is the key to successful immunization.

Judging from the amount of serum issued, there were apparently not as many pigs vaccinated in June this year as in 1922; but as the outbreak of cholera was more serious in the late summer and fall months, it caused more vaccinating than perhaps otherwise would have been done, and as the pigs were larger by that time more serum was required to vaccinate them, consequently the heavy demand for serum came at that time.

Serum sold for 90 cents per hundred c. c. until June 6, 1923, when the price was reduced to 80 cents per hundred c. c. Virus sold for \$1.25 per hundred c. c. thruout the year.

The following is a complete report of the activities of the plant for the year beginning January 1, 1923, and closing January 1, 1924:

Serum on hand January 1, 1923.....	1,110,635 c. c.
Serum bought and paid for during 1923.....	14,001,200 c. c.
Total.....	15,111,835 c. c.

Serum and virus sold, by months, as follows:

	Virus	Serum
January	21,200 c. c.	409,600 c. c.
February	10,050 c. c.	183,000 c. c.
March	10,270 c. c.	183,950 c. c.
April	9,980 c. c.	164,350 c. c.
May	24,380 c. c.	400,500 c. c.
June	88,910 c. c.	1,617,350 c. c.
July	77,890 c. c.	1,593,360 c. c.
August	151,640 c. c.	2,929,200 c. c.
September	122,250 c. c.	2,650,570 c. c.
October	94,010 c. c.	2,006,200 c. c.
November	47,210 c. c.	815,350 c. c.
December	41,280 c. c.	702,750 c. c.
Serum used by Plant.....		102,050 c. c.
Total.....	699,070 c. c.	13,758,230 c. c.

Serum on hand January 1, 1924.....	1,353,605 c. c.
Collections from all sources.....	\$128,519.10
Total expenditures	122,564.93
Money in revolving fund January 1, 1924.....	54,761.10
Inventory and other assets.....	16,640.04
Number of pigs used in retesting serum.....	770
Number of pigs used for simultaneous virus.....	743
Number of pigs on hand January 1, 1924.....	250
Number of orders for 1923.....	3,137

NORTH PLATTE SUBSTATION

Experiments with Hogs. During the winter of 1922-23 two lots of 10 pigs each were fed on white corn and tankage, against two similar lots on yellow corn and tankage and two other similar lots on yellow corn, white corn, and tankage. Alfalfa hay was fed in racks to all lots. Self-feeders were used. The daily gain on white corn was 1.61 pounds; on yellow corn, 1.58 pounds; and on a combination of white and yellow corn, 1.63 pounds. The corn and tankage required for 100 pounds gain for the first group was 340.4 pounds; for the second group, 338.9 pounds, and for the third group, 347.9 pounds.

In the summer of 1923 for a period of 60 days (with fifteen 80-pound pigs in each lot) tests were made on relative value of white and yellow corn for pigs running on sudan grass pasture. Self-feeders were used for the corn. The daily gain per pig in the lot receiving white corn was 1.28 pounds and in the lot receiving yellow corn, 1.30 pounds. Three hundred eighty-one and nine-tenths pounds of white corn and 402.2 pounds of yellow corn were required to produce 100 pounds gain.

In the comparison of sudan grass and alfalfa as pasturage and a ration of yellow corn, hogs on alfalfa showed greater gain. The daily gain on alfalfa pasture was 1.51 pounds, and for pigs on sudan grass 1.30 pounds. The corn required for 100 pounds gain was 359.3 pounds with alfalfa and 402.2 pounds with sudan. In other tests where the sudan grass was allowed to make sufficient growth to make cutting for hay necessary the sows lost weight after the sudan was cut.

In a test of sudan grass pasture, yellow corn, and tankage, as compared with the same ration without tankage, the daily gains per pig were 1.54 and 1.30, respectively.

Dairy Cattle. During the past year all grade dairy cows were sold from the herd, leaving a purebred Holstein herd, consisting of 25 cows and heifers producing milk and 26 younger females. The average production of these cows (30) finishing a lactation period in the 12-months period ending June 20, 1922, was 10,781 pounds milk and 462 pounds butter. For the year ending June 30, 1923, thirty cows produced 12,231 pounds milk and 532 pounds butter.

A mature cow in the herd, Rag Apple Blaske, in a 2-day test gave 5.76 pounds of butterfat. In a 10-months test as Junior 3-year-old, she made 449.97 pounds of butter and 10,885 pounds of milk.

Tests to determine the effect of feeding silage or not feeding silage to dairy cows receiving grain and alfalfa hay were continued during the winter of 1922-23. Two lots of cows were fed silage (or no silage with an extra portion of corn to replace the corn which would have been in the silage) during five 20-day periods, with 10-day periods intervening. During the periods while on silage rations, the cows gained 30 pounds in weight; gave 1,444 pounds milk containing 50.14 pounds butterfat, while on the ration containing no silage, they lost 12.6 pounds in weight and produced 1,474.5 pounds milk containing 53.15 pounds of butterfat.

Poultry Plant. A poultry plant containing 1,000 hens is maintained at this Station; 3 breeds, namely, Single Comb Rhode Island Reds, Barred Plymouth Rocks, and Single Comb White Leghorns, are kept. No experimental work is reported.

Horticulture. Some work of a demonstration character in varieties of apples, cherries, and plums is undertaken. The orchards are now of bearing age and have produced considerable fruit. Several acres of forestry plantations were set out about 12 and 17 years ago. A report of the growth of the different varieties will soon be made.

Field Crops. Field crops work has been continued along the same general lines as previous years. Much of the work is in co-operation with the U. S. Department of Agriculture and this has been extended thru additional help to include small grain breeding and improvement. The growing season of 1923 was unusually favorable for practically all crops except winter wheat, which was seriously injured by an epidemic of rust. The average yield of corn in one of the crop rotation fields, upon which accurate records have been kept for 17 years, was 47.3 bushels per acre. This is 27.6 bushels above the 17-year average and 13.1 bushels above the highest previous record.

Oats on fall plowing produced 63.7 bushels per acre in comparison with 52.1 bushels per acre on spring plowing. The average gain in favor of fall plowing for the 17-year period is 1.3 bushels per acre.

The benefits of practices which maintain fertility are more apparent in years like the present when moisture is plentiful. In 7 rotations, in which barnyard manure, green manure, or sod crops were used, the average yield was 53.5 bushels per acre. In 15 rotations in which no manures or sod crops were used, the average corn yield was 44.4 bushels per acre. The gain for the more fertile plats was thus 9.1 bushels per acre.

In 6 years Kanred has yielded above Turkey Red 3 times and below Turkey Red 3 times. Its average yield is 1.1 bushels per acre above Turkey Red. In the oats variety test the highest yield was made by Burt which yielded 83.1 bushels per acre. The next highest yield was 5 bushels less, made by Kherson. The average yield of 5 early varieties was 74.7 bushels per acre and of 3 late varieties 50.6 bushels per acre. In the test of corn varieties the highest yield was 63.0 bushels per acre, made by Red Flour. The flour varieties yielded about 5 bushels per acre more than the dent varieties.

In the dates-of-seeding test of 4 spring grains,—wheat, oats, barley, and rye,—each seeded on 4 different dates, the highest yields were secured in all cases from the second date of seeding which was made on April 9. The first date of seeding, made on March 29, produced the second highest yields. The yields from April 21 and April 30 seedings were much lower than from the earlier seedings.

UNION FRUIT FARM

Satisfactory progress was made with the work along this line, the purpose of which is to determine some practical phases of fruit production on a commercial basis. The 40-acre orchard at Union is being used in this experiment. This orchard was planted in the spring of 1918 to 9 commercial varieties. Twenty acres of this orchard is divided into 5 plats at right angles with the varieties. The entire 20 acres was seeded to clover in 1919 in order to make soil conditions more uniform. The entire orchard was cropped to corn in 1921. In 1922 one plat was given clean cultivation, another cultivated to soy beans drilled in rows, and the remaining plats planted to corn.

The 20 acres of this orchard not included in the cultural plats was originally set with "fillers" of early maturing varieties. The object of this method of planting is to compare the returns from the filler trees with the returns from the farm crops from the other 20 acres.

Measurements are being taken each year of all the trees. Beginning with the spring of 1923, certain blocks will be given particular cultural treatments, including clover crops, clean culture, inter-crops, and fertilization with manure.

VALENTINE SUBSTATION

The year 1923 entered with the subsoil very dry, having been depleted during the dry weather of the previous late summer and fall. The total precipitation of the growing

season was $2\frac{1}{2}$ inches below normal. Its distribution, however, was favorable for such crops as corn and forage.

Forage Crops. The average yield of 11 sorghum varieties was 6,275 pounds of forage per acre. The saccharine (sweet) sorghums averaged 565 pounds more forage per acre than the non-saccharine (grain) group.

Sudan grass produced about one-half the yield of forage that cane did and about two-thirds that of corn. Planting in rows and cultivating gave a slight increase over drilling. Seven acres of sudan grass furnished pasture for 12 winter calves, 3 sows, and 18 spring pigs for a period of 2 months.

Siberian millet outyielded common and Proso varieties.

Silage Crops. Corn produced 3 tons of ensilage, sunflowers 3.3 tons, and amber cane 5 tons per acre. The flow of milk was decreased about 10 per cent from heavy-producing cows immediately following the change to sunflower silage. Sunflowers must be cut early in this locality to avoid the loss of leaves from blight or rust.

Grain Crops. White flint corn gave a yield of 32 bushels per acre. The local dent corn gave 35 bushels per acre. These are the highest yields ever obtained on the uplands at the Station.

Winter wheat varieties gave a yield of 2.5 to 10.7 bushels per acre. Rosen rye gave 1 bushel per acre more than common rye and 5 bushels per acre more than Kanred, the highest yielding winter wheat.

In the following tabular statement is a comparison of grain yields obtained on the upland at the Station farm and the harder loam land on the table north of town:

	Station table	North table
Oats (4 varieties).....	18.5 bu. per A.	53.1 bu.
Barley, Common	15.4 bu. per A.	38.5 bu.
Emmer	12.0 bu. per A.	44.7 bu.
Rye	10.2 bu. per A.	25.4 bu.
Spring wheat (3 varieties).....	9.2 bu. per A.	19.1 bu.

Annual Legumes. Soybeans made a good growth but the yield was low on account of a poor stand. Ito San and Manchu have matured for the past 3 years with an average yield of 8 bushels per acre.

Spring vetch sown with rye was not satisfactory, due to insufficient moisture it obtained when competing with rye.

A study of clover and alfalfa production in the wet valleys has been undertaken during the past year to determine the proper depth of water table for the satisfactory production of alfalfa and clovers; also methods of soil preparation and seeding and the fluctuation in the height of the water table.

SCOTTSBLUFF SUBSTATION

The weather conditions for the season of 1923 were not entirely favorable. The spring opened early with plenty of moisture in the soil. A freeze on May 16 did severe damage, especially to beets, necessitating the replanting of a large acreage. The total rainfall from April 1 to October 1 was 16.6 inches,—considerably above the average. There were several heavy downpours that caused considerable damage by soil washing. The fall freeze was earlier than usual and caused considerable loss in potatoes that were not yet dug.

Field Crops. The work of the past season bears out results obtained in previous years, an outstanding feature being the increased yield from the inclusion of alfalfa or sweet clover in a rotation or the use of barnyard manure. The following table shows the average of yields obtained for the past year.

Yields on an acre basis from crops grown in rotation experiments showing effect of manure, alfalfa, and sweet clover on yields of different crops for the season 1923.

Crops	Un-manured	Manured	Alfalfa	Alfalfa manure	Sweet clover pastured
Potatoes.....Bu.	74.4	117.0	154.5	-----	-----
Sugar Beets.....Tons	9.08	18.83	16.95	19.21	18.50
Corn.....Bu.	29.2	-----	60.6	-----	-----
Oats.....Bu.	45.8	69.3	67.1	-----	-----
Wheat.....Bu.	7.4	-----	9.5	-----	-----

As an average for 12 years' work those rotations containing alfalfa, sweet clover, or barnyard manure have been profitable. The rotations not containing one of these have been unprofitable. The use of commercial fertilizers has not materially influenced yield, indicating that the increased yields resulted from the increased organic and nitrogen content of the soil.

Pastures. Some further work was done during the season on the effect of manure on the carrying capacity of tame grass pastures. In a comparison including no manure, 10 tons per acre annually, and 20 tons annually, the pasture receiving the applications of manure had twice the carrying capacity of the one not receiving manure. Lambs were used in this pasture experiment.

Sweet Clover and Native Pasture. In this test 3 lots of 25 steers each were pastured,—one on sweet clover alone, one on native grass alone, and one on sweet clover plus corn, giving first a comparison of native grass and sweet clover and second, some information on the possibilities of fattening cattle on sweet clover pasture by corn feeding. All the steers were 3-year-olds and averaged 757 pounds per head at the beginning of the test. The corn ration for the lot receiving corn was increased until they were receiving 20 pounds of corn per head per day. At the end of the period the average weight of the steers was 1,040 for the corn and sweet clover, 971 for sweet clover alone, and 1,012 for those on native grass pasture. The steers were all shipped to Omaha and the lots weighed there in the order named,—1,012, 890, and 982 pounds, the greatest shrinkage being on the lot receiving sweet clover alone. The total gain made per steer was 255 pounds for corn and sweet clover, 133 for sweet clover alone, and 225 for native grass pasture. This work will be continued during the following year.

Lamb Feeding Experiments. During the winter 13 lots of lambs were fed on various rations. This season's work completes 3 years' work along this line and is summarized and published in Bulletin No. 194 of the Agricultural Experiment Station. Further work is contemplated in lamb feeding.

Hogs—Summer vs. Winter Finishing. A test comparing winter finishing and summer finishing of fall farrowed pigs was conducted with 4 lots of 10 shoters each. The cost of 100 pounds of gain was \$7.74 for those finished in the winter and \$6.88 for those finished in the summer. The market value per hundred was \$6.50 for the winter-finished hogs and \$8.40 for the summer-finished. Those finished in the winter gave a loss of \$3.00 per head, while those finished on pasture in the summer made a profit of \$3.08 per head.

Self-Feeder Compared with Limited Rations. For a period of 136 days 2 lots of hogs consisting of 37 head each were run on alfalfa pasture. Both lots received rations of corn

and barley, one lot being fed from a self-feeder where they had a continual supply of grain, the others receiving an amount of grain equal to 2 per cent of their live weight. During the 136-day period the lot on the self-feeder made a total gain of 4,095 pounds. Those on a 2 per cent ration made a gain of 2,995 pounds. The cost of the grain fed for the lot on the self-feeder was \$262.55; for the lot on 2 per cent ration, \$155.84. Figuring the gain at \$7.15 per hundred the lot on the self-feeder showed an average loss of 25 cents per hog, while those on limited ration showed a profit of 50 cents per hog.

Comparison of Tankage and Alfalfa Hay for Feeding Hogs. In a 57-day test 2 lots of hogs containing 35 each were fed, one lot receiving corn and tankage, the other lot corn and alfalfa hay. During the period the lot on corn and tankage made a total gain of 2,210 pounds and the lot on corn and alfalfa 1,645 pounds. The cost of 100 pounds of gain was \$6.76 for the corn and tankage and \$6.72 for the corn and alfalfa.

CHANGES IN STATION STAFF

Mr. R. W. Dawson, Assistant in Entomology, resigned May 31, 1923.

Mr. J. A. Luithly, Associate in Dairy Husbandry, resigned June 30, 1923.

Mr. W. H. Savin, Assistant in Animal Husbandry, resigned July 31, 1923.

Mr. P. A. Downs was appointed Associate in Dairy Husbandry August 1, 1923.

Mr. H. D. Fox was appointed Assistant in Animal Husbandry September 1, 1923.

Mr. E. O. Anderson was appointed Assistant in Dairy Husbandry August 1, 1922.

PUBLICATIONS

The publications of the Station since those named in the last Annual Report are as follows:

Thirty-sixth Annual Report. Presented to the Governor February 1, 1923. 2,000 copies.

Bulletin No. 187. Purchasing Power of Nebraska Grains. By H. C. Filley and E. A. Frerichs. March, 1923. 7,000 copies.

Bulletin No. 188. Productive Seed Corn. By T. A. Kiesselbach. April, 1923. 10,000 copies.

Bulletin No. 189. Some New Hybrid Strawberries. By R. F. Howard and C. C. Wiggans. April, 1923. 4,000 copies.

Bulletin No. 190. Crop Rotation Under Irrigation. By James A. Holden. April, 1923. 5,000 copies.

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Bulletin No. 191. Nebraska Farm Homes: A comparison of some living conditions of owners, part-owners, and tenants. By J. O. Rankin. May, 1923. 4,000 copies.

Bulletin No. 192. Dry Farming Investigations at Scottsbluff Substation. By L. L. Zook. July, 1923. 4,000 copies.

Bulletin No. 193. Sixteen Years' Grain Production at the North Platte Substation. By L. L. Zook and W. W. Burr. July, 1923. 5,000 copies.

Bulletin No. 194. Lamb Feeding Experiments in Western Nebraska. By James A. Holden. August, 1923. 5,000 copies.

Bulletin No. 195. The More Important Poultry Diseases. By L. Van Es and H. M. Martin. October, 1923. 10,000 copies.

Bulletin No. 196. Nebraska Farm Tenancy: Some community phases. By J. O. Rankin. October, 1923. 5,000 copies.

Bulletin No. 197. Winter Lamb Feeding: 1919-20, 1920-21, 1921-22. By W. H. Savin. October, 1923. 5,000 copies.

Bulletin No. 198. Factors Affecting the Price of Farm Products. By H. C. Filley. November, 1923. 5,000 copies.

Research Bulletin No. 24. Seed Potato Investigations. By H. O. Werner and R. F. Howard. December, 1923. 5,000 copies.

Research Bulletin No. 25. A Study of the Environmental Conditions Influencing the Development of Stem Rust in the Absence of an Alternate Host. II. Infection Studies with *Puccinia graminis tritici*, Form III and Form IX. By George L. Peltier. December, 1923. 3,000 copies.

Experiment Station Circular No. 20. The Plains False Wireworm and Its Control. By M. H. Swenk. July, 1923. 2,000 copies.

Experiment Station Circular No. 21. The Abortion Problem in Farm Live Stock. By L. Van Es. September, 1923. 10,000 copies.

Experiment Station Circular No. 22. Ice Cream Ingredients. By H. P. Davis, Benjamin Masurovsky, and John A. Luithly. January, 1924. 5,000 copies.

ARTICLES IN RESEARCH JOURNALS

Competition as a Source of Experimental Error in Corn Yield Tests. By T. A. Kiesselbach. Jour. Amer. Soc. Agron. January issue.

Endogenous Metabolism of Hens and Capons. By C. W. Ackerman, M. J. Blish, and F. E. Mussehl, Poultry Science, Vol. II, September, 1923.

ACKNOWLEDGMENTS

The agricultural press and the daily and weekly newspapers, especially those papers located within the state, have shown their appreciation of the work of the Experiment Station by giving liberal space to experimental work reported and in every way facilitating the extension of useful agricultural knowledge.

**THE AGRICULTURAL EXPERIMENT STATION
OF NEBRASKA**

**FINANCIAL STATEMENT OF MONEY RECEIVED FROM THE
UNITED STATES GOVERNMENT**

HATCH FUND**Receipts**

Received by the State Treasurer, who is also the treasurer
of the University of Nebraska, installment for the fiscal
year ended June 30, 1923, under act of Congress ap-
proved March 2, 1887. Total.....\$15,000.00

Expenditures

For salaries\$15,000.00
Total.....\$15,000.00

ADAMS FUND**Receipts**

Received by the State Treasurer, who is also the treasurer
of the University of Nebraska, installment for the fiscal
year ended June 30, 1923, under act of Congress, ap-
proved March 16, 1906. Total.....\$15,000.00

Expenditures

For salaries\$15,000.00
Total.....\$15,000.00

At Lincoln, Nebraska,
January 26, 1924.

L. E. GUNDERSON,
Finance Secretary.

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FINANCIAL STATEMENT OF MONEY RECEIVED FROM THE STATE OF NEBRASKA

Statement of expenditures for the Agricultural Experiment Station of the University of Nebraska by accounting classification units, and from all State funds (exclusive of Federal funds).

SALARIES AND WAGES

Regular employes	\$61,726.89	
Temporary employes	1,548.39	
Fees, claims, etc.....	63.22	
Total.....		\$ 63,338.50

SUPPLIES

Office supplies	\$ 926.37	
Laboratory supplies	4,479.79	
Fuel	1,528.43	
Food	1,452.03	
Educational supplies	296.23	
Janitor supplies	238.95	
Feed	28,436.58	
Agricultural supplies	1,539.92	
Total.....		\$ 38,898.30

EXPENSE

Office expense and postage.....	\$ 235.67	
Telephone and telegraph.....	251.09	
Freight, express and drayage.....	938.59	
Water, heat, light and power.....	2,981.31	
Publishing, printing and advertising.....	6,406.41	
Traveling expense	2,995.85	
Miscellaneous	16,632.38	
Total.....		\$ 30,441.30

MATERIALS, PARTS AND REPAIRS FOR UPKEEP

Buildings	\$ 4,249.06	
Grounds	552.49	
Autos and trucks.....	669.93	
Upkeep of property.....	2,799.75	
Total.....		\$ 8,271.23

FINANCIAL STATEMENT—Continued

EQUIPMENT

Furniture and fixtures.....	\$ 971.83	
Laboratory supplies	4,020.40	
Livestock	17,142.58	
Machinery	7,129.06	
Books	289.20	
Total.....		\$ 29,553.07

LANDS AND BUILDINGS

Land	\$ 2,635.43	
Buildings	5,634.91	
Total.....		\$ 8,270.34

FIXED CHARGES

Claims and refunds.....	\$ 7.50	
Total.....		\$ 7.50
Grand Total.....		\$178,780.24

This includes expenditures for the central station at the Agricultural Campus and the substations at Scottsbluff, North Platte, and Valentine.

At Lincoln, Nebraska,
January 26, 1924.

L. E. GUNDERSON,
Finance Secretary.

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UNIVERSITY OF NEBRASKA PRESS